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Legal and Operational Aspects of Compliance with Scientific Integrity

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Abstract: Ensuring scientific integrity is of utmost importance in the research community, as it forms the foundation of reliable and credible scientific knowledge. Compliance with scientific integrity involves adhering to ethical principles, research standards, and legal regulations that promote transparency, honesty, and accountability. Fabrication, falsification, and plagiarism are common forms of research misconduct that undermine the credibility and trustworthiness of scientific findings. Institutions must establish clear policies and procedures to address and prevent such misconduct, including mechanisms for reporting, investigation, and appropriate disciplinary actions. This article examines the legal and operational aspects related to compliance with scientific integrity, highlighting key considerations and best practices in this critical domain.

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1. Introduction

General trust in scientific integrity has been shaken in the last years globally. For example, the Stanford President resigned in 2023 after a report found flaws in his research.[1] In 2011, the Bayreuth University withdrew the doctorate of the then Minister of Defence because some passages could be identified as plagiarism.[2] Plagiarism allegations were also made against a professor at the University of Zurich in 2022,[3] while a student at the same university plagiarized a fellow student's work for his Bachelor thesis, and received the lowest grade as a result. He unsuccessfully challenged this in court through several instances in 2023.[4] While serious breaches of academic integrity still seem to be the exception (far more frequent are errors with source references due to a lack of better knowledge or time pressure), a *meta*-analysis revealed that 1.97% of scientists admitted to having fabricated, falsified or modified data on at least one occasion.[5] Unfortunately, this may be just the tip of the iceberg, and procedures for monitoring scientific misconduct are not yet well established.[6] Even if a serious breach can lead to a retraction of the scientific publication, the consequences for science can be devastating, and it often terminates the career of the errant scientist. Admittedly, plagiarism has never been easier than today owing to digitalization. Text fragments available online can simply be copied and pasted and, if necessary, slightly adapted by rearranging the sentence. Tools like ChatGPT or CopyAI even make it possible to have entire academic papers written by artificial intelligence. These procedures not only compensate for the lack of one's own creative power, but even save the trouble of copying. How universities will deal with this challenge is still unclear. What is certain, however, is that this development cannot be stopped.

At the same time, it has never been easier to detect plagiarism. The more texts are digitized and available online, the higher the probability that matches can be detected by plagiarism software or internet-based text matching.[7] It is therefore of paramount importance, both for the student as a future researcher and for the professor, to have an in-depth knowledge of the applicable regulations in this area. A professor's failure to communicate this knowledge to their students can also be considered a violation of academic integrity. Therefore, knowledge or compliance with the applicable rules is of the utmost importance.

In this article, we discuss a selection of possible types of violations of scientific integrity including the corresponding legal bases at the level of Swiss federal law and show some examples. Furthermore, we elaborate on legal difficulties and regulatory aspects and assess benefits and disadvantages from an overall perspective.

2. A Selection of Possible Types of Violation of Scientific Integrity

A primary concern in maintaining scientific integrity is preventing research misconduct. Fabrication, falsification, and plagiarism are common forms of research misconduct that under-

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mine the credibility and trustworthiness of scientific findings. While data fabrication is an obvious scientific misconduct, determining data falsification (*e.g.* through data analysis) can be more difficult. Institutions must establish clear policies and procedures to address and prevent such misconduct, including mechanisms for reporting, investigation, and appropriate disciplinary actions (see section 3.1). Science is an open system that aims to advance knowledge and is committed to the intersubjective comprehensibility of statements. All scientists base their research on the findings of others. They must therefore be able to trust that these earlier works have not been manipulated and that they, in turn, can be retraced by means of precise source references. If this expectation is violated, not only the quality of the respective work suffers, but also the precision of the professional discourse. This in turn can damage the credibility of the scientific community as a whole.[8]

2.1 *Plagiarism*

Plagiarism is often associated with the writing of academic papers. Specifically: 'Plagiarism refers to situations in which one's own performance cannot be sufficiently distinguished from another's or one's earlier own performance'.[9]

In academia, upholding scientific integrity necessitates the clear attribution of references to external (non-own) intellectual contributions. This ethical principle underscores the importance of acknowledging and respecting the original authors. Appropriating someone else's work not only lacks integrity but also demonstrates a disregard for the original author. When directly quoting or incorporating excerpts from foreign texts, it is imperative to accurately cite and provide proper references. Likewise, when incorporating foreign ideas, theories, or thought processes into one's own work, it is essential to attribute the source.

The act of paraphrasing without appropriate citation invariably amounts to plagiarism. Even quotes that appear indirectly referenced, where the original text has undergone minimal modification (for instance, through the substitution of specific terms or the reordering of sentences), may be construed as instances of plagiarism. Regardless of whether the omission of citation was inadvertent or borne out of ignorance, it remains an instance of plagiarism.

However, plagiarism is only punishable by law if it was done intentionally, and a criminal complaint has been filed (article 68 Federal Act on Copyright and Related Rights [CopA]). As it is often difficult to prove intentional omission of the source citation, many infringements remain without criminal consequences. For a sanction to be taken, plagiarism – or more broadly fraud – must be proven, a suspicion is not enough.

With regard to plagiarism, the position of the Federal Supreme Court could not be clearer: "(…) le plagiat est une faute grave, contraire à l'éthique et à l'intégrité de la recherche académique".[10]

Swiss courts consistently refuse the possibility of justifying plagiarism by exceptional circumstances.[11] For instance, a lack of time in writing a paper due to external factors, a lack of supervision, or health problems[12] would not be accepted.

Example (Judgment of the Federal Administrative Court): A final thesis in the context of an Executive Master of Business Administration program at the Swiss Federal Institute of Technology Lausanne (EPFL) was subjected to plagiarism software and the plagiarism check revealed a similarity score of 24%. The author of the thesis was accused of having reproduced passages word for word without having marked them as citations. As a result, EPFL assessed the thesis as failed. The student appealed against this decision to the court. The Federal Administrative Court came to the conclusion that the assessment of the thesis as failed due to plagiarism was proportionate and not objectionable.[13]

However, plagiarism must be distinguished from information that is not subject to citation. Basic knowledge, for example, does not have to be substantiated with a source as long as its presentation was not taken from another source. Basic knowledge is knowledge that is assumed to be known in a subject. Example: A bachelor's thesis in physics does not have to cite that the theory of relativity was developed by Albert Einstein.

2.2 *Ghostwriting*

The writing of scientific texts, especially qualification theses, by another person, a so-called ghostwriter, is also to be regarded as a violation of the rules of good scientific practice. However, proof is best obtained in the context of the oral defence of a doctoral thesis.

Examples: In 2017, the universities of St. Gallen and Bern took the position that anyone who submits work that they did not write themselves is liable to prosecution for falsification of documents. Pursuant the criminal law, offenders face up to five years in prison. However, the prosecution of fraudulent academic titles is difficult, because ghostwriting agencies do not plagiarize, but write original works (see below section 3.1.4).

In the canton of Geneva, as part of a master's course in neuroscience, a student had difficulty writing an academic paper and sought help by posting task and topic of the paper on an online platform (selling 'ghostwriting'). The work ordered (the academic paper) was then returned to the student and paid by the latter. The court seized with the case stated that using someone else's work and passing it off as one's own deceives the professor in regard to the student's level of knowledge and therefore constitutes fraud (but not in the criminal sense according to art. 146 Swiss Criminal Code [SCC]).[14]

2.3 *Image Misrepresentation*

Scientific misconduct of figures includes image cloning (*e.g.* copying and mirroring images to use them in a different context) and image misrepresentation. Most common examples of image misrepresentation are (i) deletions and additions to the original image, (ii) brightness and contrast adjustments that eliminate information, (iii) and combining images that were not part of the same measurement.[15] While some image adjustments are accepted, they must be done with upmost care to ensure accurate representation of the original data and must be disclosed to the readers.

Examples of image adjustments and image misrepresentation are shown in Fig. 1. An original electron microscopy image in Fig. 1a shows Al_2O_3 nanoparticles (light grey) decorated with Platinum (Pt) clusters (dark grey).[16] The inset shows a magnification of the Pt cluster and its lattice fringes (regular pattern). Adjusting the contrast and brightness of this image results in even darker Pt particles in comparison to the lighter Al_2O_3, which allows for better distinction and visibility of the lattice fringes in the inset (Fig.1b). This adjustment does not eliminate information contained in the original image; hence it is accepted if disclosed correctly to the readers. This is different for Fig. 1c and d: Fig. 1c shows an original dark field electron microscopy image of such Al_2O_3 nanoparticles (light grey) decorated with Pt clusters (white). Adjusting the contrast and brightness leads to a loss of small features, as indicated by the dashed circles (Fig. 1d). As a result, the adjusted image gives a false impression of the size distribution of such Pt clusters (*e.g.* Pt clusters with sizes smaller than 5 nm disappear) and is hence an image misrepresentation.

2.4 *Responsible Authorship*

Responsible authorship practices play a vital role in scientific integrity. Researchers must accurately attribute contributions, acknowledge collaborations, and adhere to guidelines on authorship order and criteria. Transparent and fair authorship practices

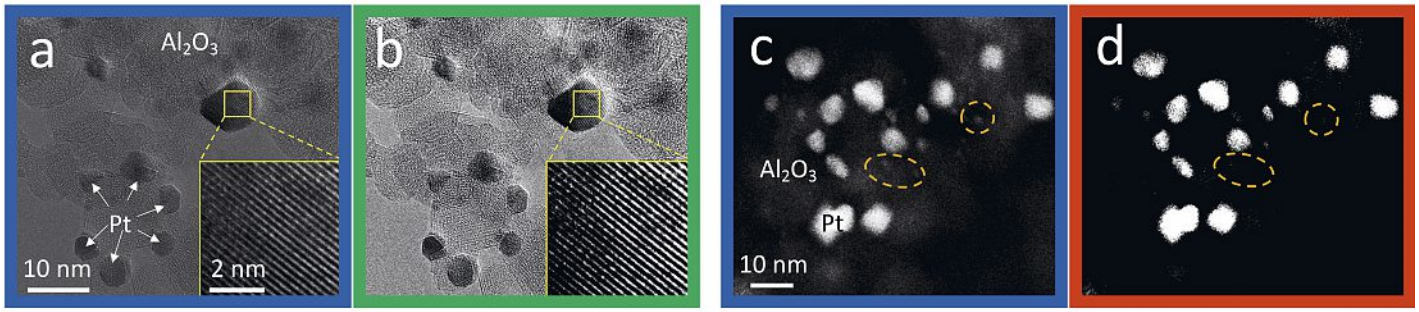

Fig. 1. a) High resolution transmission electron microscopy (HRTEM) image of Al_2O_3 nanoparticles decorated with Pt clusters. b) Identical image to a) after adjusting the contrast for better visibility of Pt particles and lattice fringes (inset). c) High angle annular dark field scanning transmission electron microscopy (HAADF-STEM) image of Al_2O_3 nanoparticles with Pt clusters. d) Identical image to c) after adjusting the contrast, which leads to a loss of small features (dashed circles). Data was reproduced from ref. [16], see also section 3.1.2.

foster accountability and recognition for individual contributions, preventing unethical practices such as ghostwriting and honorary authorship. Example: Responsible authorship disclosure is a key element of scientific integrity. Most journals[17] have binding guidelines in this regard. Likewise, universities and other organizations have clear rules (see for example section 3.3 for the ETH Domain).

2.5 *Conflicts of Interest*

Identifying and managing conflicts of interest is crucial to maintaining scientific integrity. Researchers must disclose any potential conflicts, such as financial interests or personal relationships that may influence their research or objectivity. Institutions should establish transparent disclosure policies and mechanisms for managing conflicts of interest to ensure unbiased research outcomes. For instance, the Swiss Federal Institute of Technology Zurich (ETH Zurich) has a clear regulation on what shares professors or employees may hold in spin-offs (max. 20%). Example: In 2020, an external investigation report by the University Hospital of Zurich confirmed serious allegations against a Clinic Director; in particular, he was accused of not disclosing his vested interests.[18]

3. Legal Framework in Switzerland

(A selection of relevant legal bases and possible legal consequences)

Compliance with scientific integrity is influenced by various legal frameworks that govern research activities. Laws, regulations, and guidelines differ across jurisdictions, but they commonly address issues such as research misconduct, data protection, intellectual property, conflicts of interest, and responsible authorship. Researchers and institutions must familiarize themselves with these legal requirements and ensure strict adherence to avoid legal repercussions and reputational damage.

In addition to the various federal acts (see section 3.1), there are other implementing provisions that must be observed (see sections 3.2 and 3.3). The sheer volume and density of regulations means that it is difficult for non-lawyers to assess which provisions are specifically applicable and how a certain conduct is to be assessed from a legal point of view. This contribution is limited to federal law in Switzerland; the law of the cantonal universities is not considered.

3.1 *Relevant Regulations at Federal Level*

3.1.1 *Federal Act on Data Protection*[19] *(FADP, «DSG» in German)*

Data protection is another vital aspect of compliance with scientific integrity. Researchers must handle and store data in accordance with applicable data protection laws and regulations. This involves obtaining informed consent, protecting personally identifiable information, and ensuring the secure storage and transmission of data. Compliance with data protection regulations not only upholds scientific integrity but also safeguards the privacy rights of research participants. Example: the cited judgements (for example in section 2.1) are always anonymized.

3.1.2 *Federal Act on Copyright and Related Rights*[20] *(CopA, «URG» in German)*

Respecting intellectual property rights is crucial to maintaining scientific integrity. Researchers must be aware of copyright laws, patents, and licensing requirements when using others' work or sharing their own findings. Proper citation practices, obtaining necessary permissions, and acknowledging intellectual contributions are essential to avoid plagiarism and copyright infringement.

Example: for the reproduced data in section 2.2, which is image material from our co-author no copyright permissions were required. However, this is an exception from the specific journal[21] and must always be examined on a case-by-case basis; other journals would require to obtain permission for reproduced data. Finally, a precise reference to the source is always required.

Excursus: *The Role of ChatGPT and the Copyright Challenge*

In recent years, the use of artificial intelligence (AI) tools such as ChatGPT in academic research has raised questions about the potential impact on scientific integrity and the challenges of protecting intellectual property rights. One of the key challenges associated with the use of ChatGPT in academic research is the potential for copyright infringement. ChatGPT can generate text that is similar or identical to existing copyrighted works, which can raise legal and ethical concerns. In Switzerland, copyright protection applies to all original works of authorship, including literary, artistic, and scientific works. Copyright protection is automatic, and no registration is required. Copyright owners have the exclusive right to reproduce, distribute, and display their works, and to create derivative works based on their original works. Thus, the use of copyrighted works *via* ChatGPT without permission or a valid exception can constitute copyright infringement. Ignorance does not protect from the law.

3.1.3 *Federal Act on the Promotion of Research and Innovation*[22] *(RIPA, «FIFG» in German)*

The RIPA also provides a legal basis for possible sanctions offences (Art. 12 RIPA): written reprimand; written warning; reduction, suspension, or repayment of the contributions; or temporary exclusion from making further applications. Furthermore, the research funding institutions may, if they have good reason to believe that the rules are being breached, within their promotion and controlling mechanisms, obtain information from national or

foreign institutions or persons concerned and provide information to such institutions or persons.

3.1.4 *Swiss Criminal Code*[23] *(«SCC», «StGB» in German)*

Fraud is a broader category than plagiarism and encompasses the latter notion. In the context of this publication, fraud would be constituted by any fact (or omission) of an academic (student, professor or other) that would allow them to improve their situation in a way that is contrary to the law, a regulation or even an instruction. The most obvious case is cheating in exams. However, fraud in the criminal law sense according to art. 146 SCC is more narrowly defined.

The elements of fraudulent intent, pecuniary loss by deception and the intention to enrich oneself are unlikely to ever be met - let alone proven. Hence, convictions for fraud in the context of scientific misconduct are very rare.

The question of a criminal sanction for 'ghostwriting' has recently arisen in Switzerland.[24] Even if the goals pursued were to be of a pecuniary nature, it cannot, in our opinion, be qualified as fraud for lack of damage to the university or another institution or individual.

According to some scholars, an academic paper qualifies as a document ('Urkunde') in the sense of art. 251 SCC, which would make it possible to convict the author of forgery of documents. In our view, however, this interpretation of a 'document' in the sense of the law is too broad and should therefore be rejected.

However, obtaining a false certificate by fraud (art. 253 SCC) could be considered: Even if university diplomas are not mentioned in legal doctrine as examples of the application of the mentioned article, it is to be noted that university diplomas are indeed documents intended and suitable for producing legal effects (*e.g.* admission to certain research or study programs, access to certain regulated professions, scholarships and subsidies, publications, *etc.*).

The reprehended behaviour is a deception, causing an error on the part of the authority, leading the latter to establish a false fact. However, only a fraudulent act that leads to obtaining a diploma (*i.e.* without which the student would not have obtained the diploma) can be punished.

In contrast to forgery of documents, it is not necessary to demonstrate that the authors intended to obtain benefit themselves or for a third party in any way; it is sufficient to obtain the false document or to use the document thus obtained.

The third party helping - typically the ghostwriter - should be classified as an accomplice rather than a co-perpetrator, since they are not seeking to obtain the title themself but is helping the principal perpetrator to obtain it.

Another example: Between September and November 2013, a doctoral student submitted a paper she had written to four different conferences, untruthfully listing her former doctoral advisor and professor as a co-author. In reality, the latter had not participated in the preparation of the scientific paper.[25] In the case under review, the only question was whether the professor (falsely listed as co-author) was entitled to appeal against the prosecutor's order to stay proceedings, which the Federal Supreme Court answered in the negative.

It may be true that in the case under review, the respondent affected the complainant's private interests, namely his professional reputation, by indicating that he was a co-author of the article he submitted to various conferences. However, the student's action was not directly aimed at disadvantaging the professor nor were his interests directly affected by it. The authorities therefore rightly assumed that the professor was not a person suffering harm in the sense of Art. 115 para. 1 Swiss Code of Criminal Procedure (CCP) and that, as a mere complainant, he was not entitled to file an appeal against the decision of the public prosecutor's office to stay the proceedings. The question of whether the conduct would have constituted fraud under criminal law was left open by the Federal Supreme Court (and would have to be answered in the negative according to the authors' view).

3.2 *Regulations of the Swiss National Science Foundation (SNSF)*

In recent years, the SNSF has issued numerous sanctions for plagiarism in research proposals and documents its practice on its website.[26] Example (translation of the German text):[27] In this case, "626 words (8% of a research plan) were taken without citation of source from 3 peer-reviewed research articles. All were from a research group that had no reference to the application. Although the amount of copied text was relatively small, it related to the objectives of the project and, in particular, to aspects that the applicant explicitly presents as 'novel'. In addition, the applicant had intentionally misquoted numerical data from a third research group. The fact that the applicant had remained intransigent in their statement and had even attempted to justify their behaviour with obvious false statements compounded the difficulty. The SNSF Commission for Scientific Integrity (IC) conducted an investigation and reported to the Presidium of the National Research Council. The sanction was a 2-year suspension of the application."

3.3 *Specific Regulations in the ETH Domain (measures under higher education law)*

The two Federal Institutes of Technology (ETH Zurich,[28,29] and EPFL[30,31]) currently have each their own guidelines and rules of procedures, some of which are currently under revision (namely ETH Zurich). The research institutes of the ETH Domain have common guidelines and procedural regulations.[32] The ETH Domain is currently examining whether and to what extent it is possible to issue an overarching, joint legal ordinance for the entire ETH Domain, in which the most important principles are regulated, and which is closely based on the Code.

4. Regulatory and Organizational Aspects

4.1 *Additional Compulsion or Best Practice?*

When ensuring scientific integrity, there are two main approaches: additional compulsion and best practices.

Additional compulsion involves implementing stricter regulations, guidelines, and enforcement mechanisms to ensure compliance. It aims to deter and address research misconduct effectively through mandatory requirements like rigorous documentation, independent audits, and stricter disciplinary actions. However, it may lead to increased bureaucracy and a culture of compliance based on fear of punishment. Detailed methods on such an approach using Benford's law are provided in the literature.[6]

The best practice approach focuses on promoting a culture of responsible research through guidance, education, and a shared commitment to integrity. It encourages self-regulation, professional ethics, and voluntary measures beyond legal requirements. Best practices include regular ethics training, transparent reporting standards, collaborative peer reviews, and open dialogues on ethical challenges. They prioritize prevention, education, and building a community of researchers dedicated to upholding scientific integrity. Best practices complement legal requirements, providing flexibility to adapt to evolving research landscapes and ethical challenges.

A great deal of support in this context is provided in Switzerland on the one hand by the 'Code of conduct for scientific integrity' of the Swiss Academies of Arts and Sciences (2021) and will be provided on the other hand by the competence centre to be newly founded (see section 4.2).

4.2 *Organizational Aspects: Swiss Competence Centre for Scientific Integrity and Other Organizations Abroad*

Currently, a national competence centre for research integrity is to be established in Switzerland. Its task will mainly be to provide support and advice for the universities and individuals and will thus contribute to the improvement of the procedures. The Swiss competence centre will not conduct any investigations. It aims to promote a positive culture of research integrity and to support the fight against scientific misconduct.

5. Conclusions

Compliance with scientific integrity requires a multifaceted approach that encompasses legal and operational considerations. Researchers and institutions must be well-versed in relevant legal frameworks, establish robust policies and procedures, and promote a culture of ethical conduct and transparency. By prioritizing compliance with scientific integrity, we can uphold the credibility of scientific research and ensure the advancement of knowledge for the betterment of society.

Looking to the future, especially with regard to artificial intelligence, scientific integrity will become even more important. It is crucial that students and researchers, no matter what level, are sensitized to this very early on. Without mutual trust, there will be no scientific integrity.

The authors of this article conclude that serious cases of scientific misconduct are rare, but any consequences can be severe for the scientific community and can ruin an entire career. Far more common, however, is lack of knowledge, time pressure or negligence, but ignorance does not protect against the law. Good leadership practice and raising awareness of how to quote correctly is therefore of paramount importance.

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